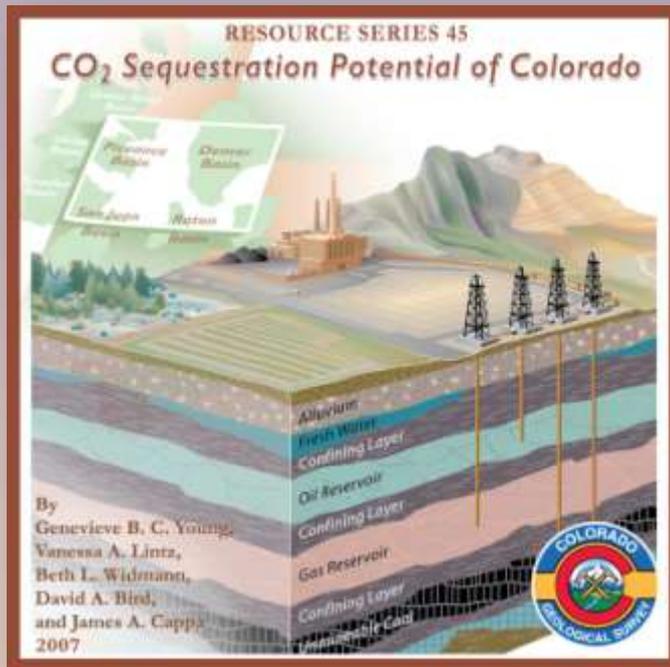


Carbon Sequestration in Colorado and the Craig Project



Vince Matthews

State Geologist and Director

Northwest RAC

May 13, 2010

COLORADO GEOLOGICAL SURVEY

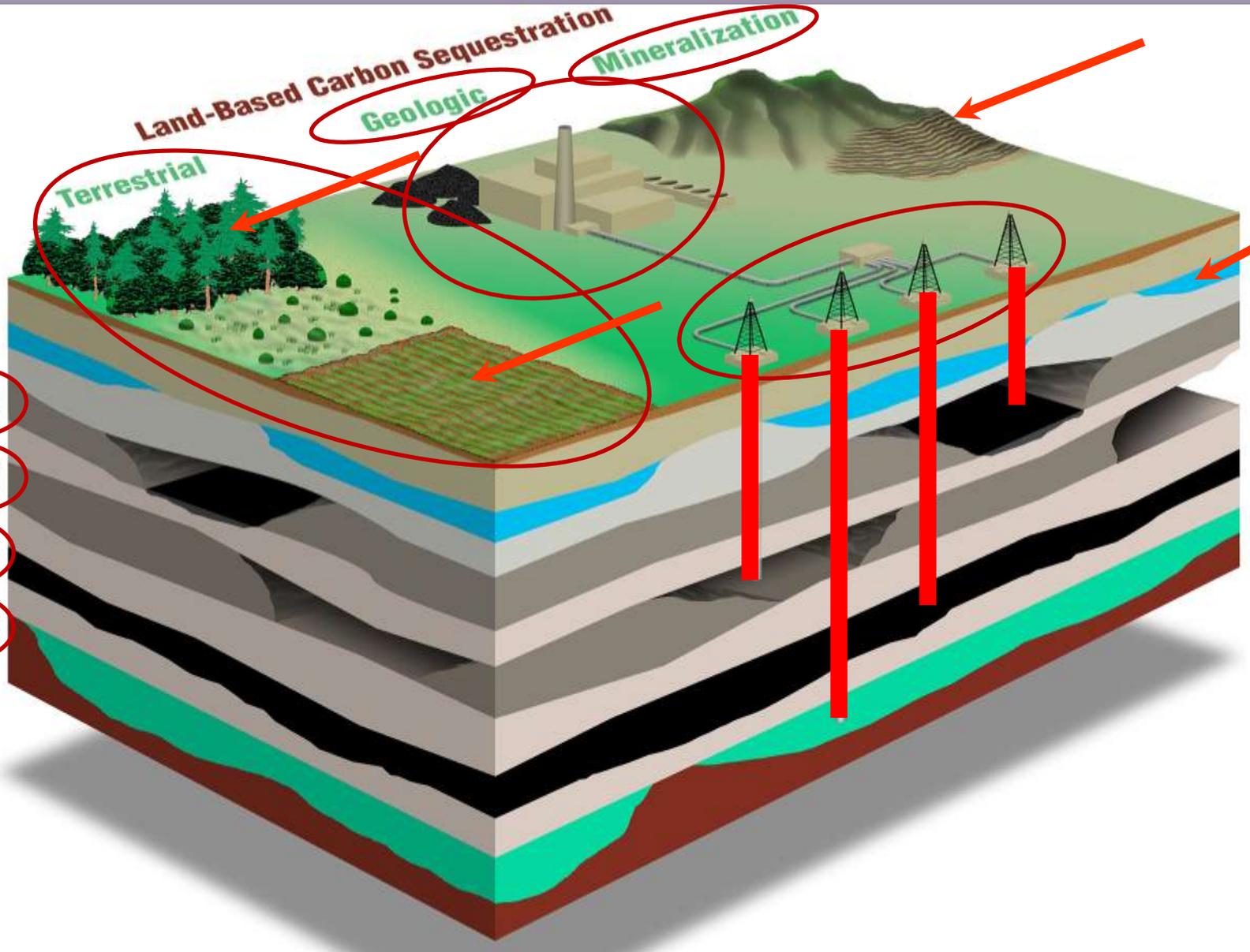


Geologic (Sub-Surface) Sequestration

Land-Based Carbon Sequestration
Geologic Mineralization

Terrestrial

- Oil Wells
- Gas Wells
- Coal Seams
- Saline Aquifers

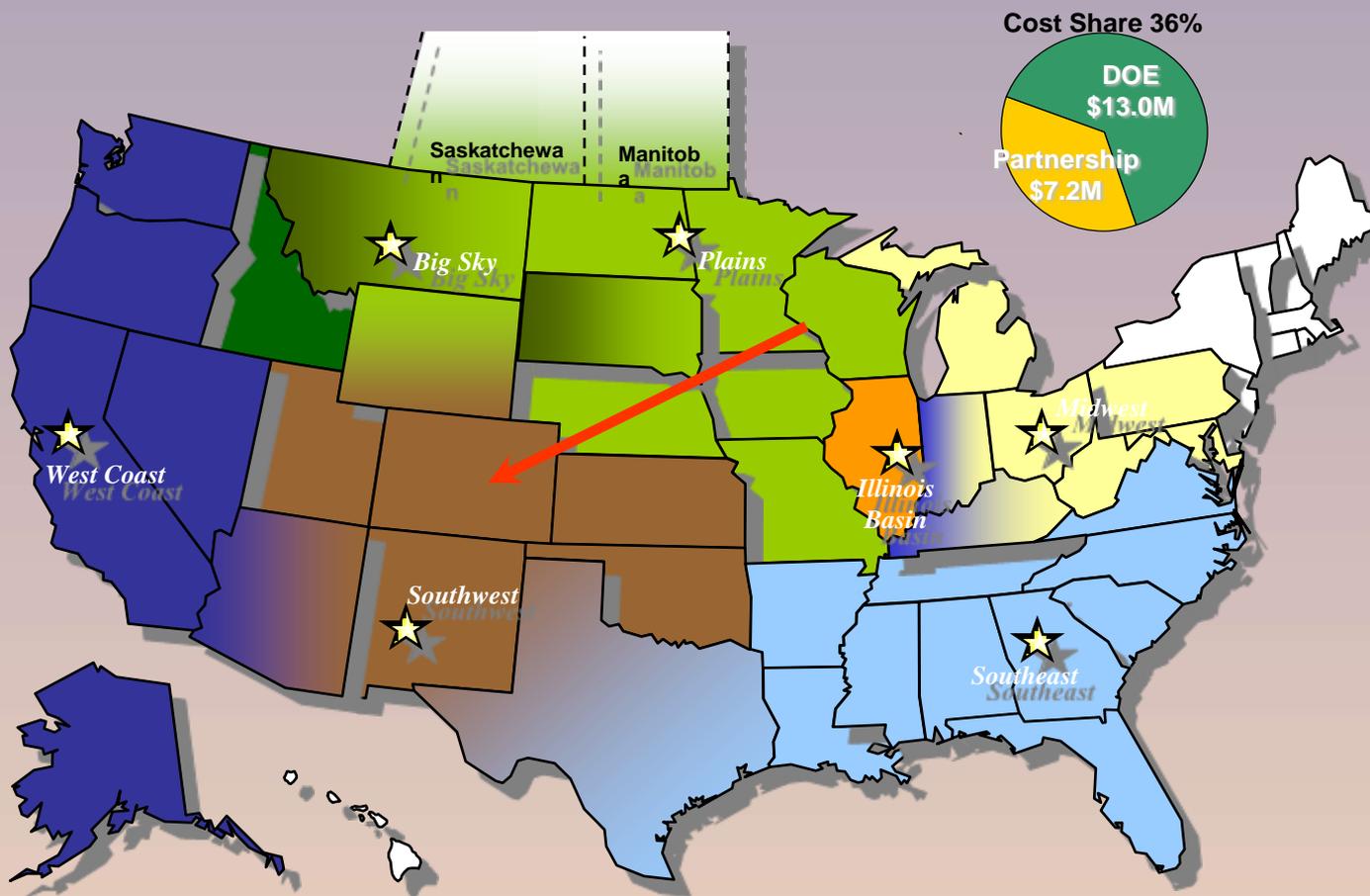


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Regional Carbon Sequestration Partnerships

Seven Partnerships Established in Five Geographic Regions



Representing:
154 Organizations
2 Canadian Provinces
3 Indian Nations
40 States

Three-Phased Approach

Phase I (Planning) 2003-05

- 7 Projects
- \$1.5 million per project
- Overall ~ 40% cost share



Phase II (Proof-of-Concepts 2005-09)

- ~ \$3 to \$5 million per year/project
- minimum 20% cost share
- ~ 5 Regions



Phase III (Deployment) 2009-19

- ~ \$65 million per project
- > 20% cost share
- ~ 5 Projects

Phase I 2003-05

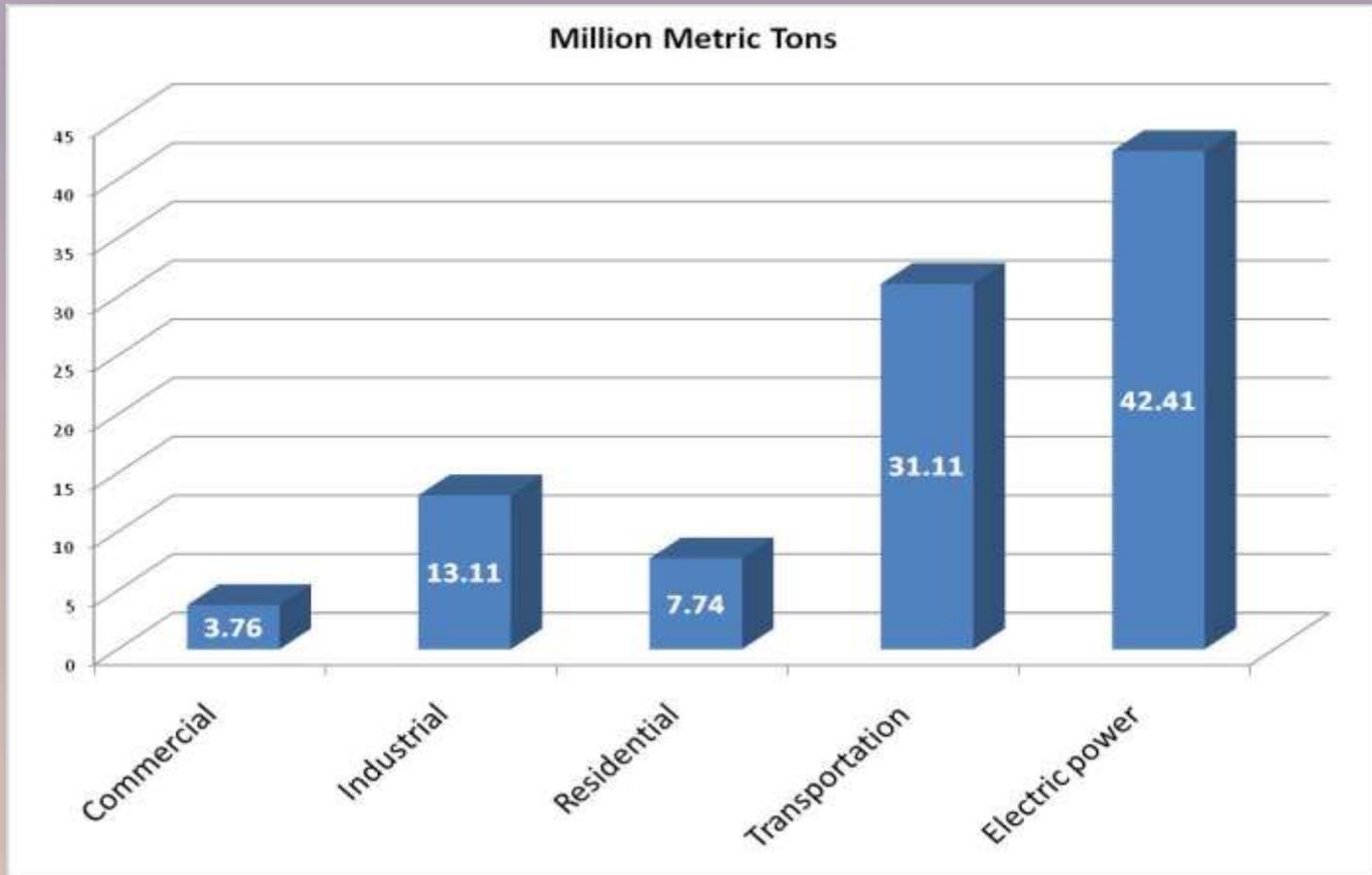
Characterize the Major Colorado Sources

Delineate Pilot Study Areas around major sources

Identify and characterize the various geologic sinks in potential pilot areas



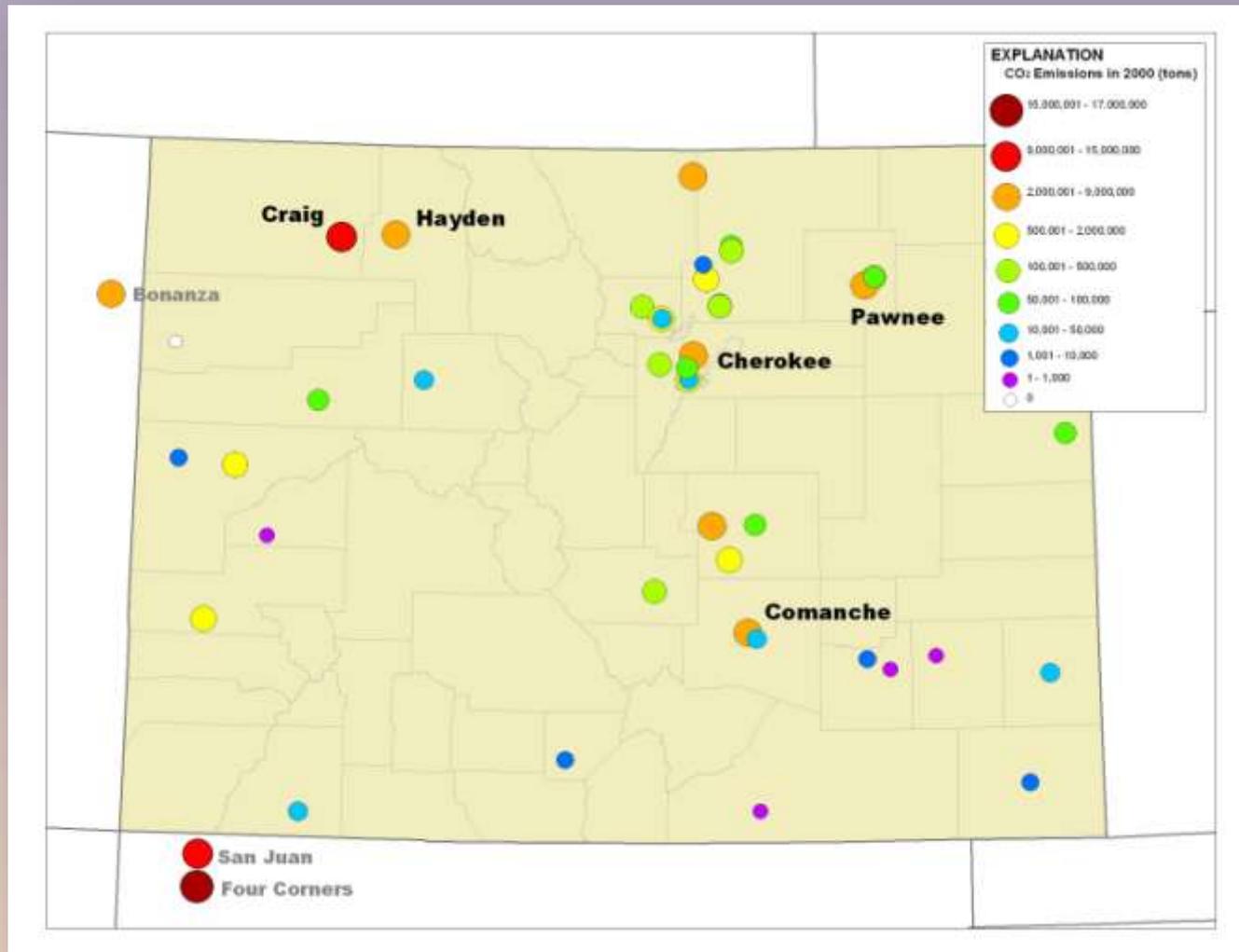
CO2 Emissions in Colorado

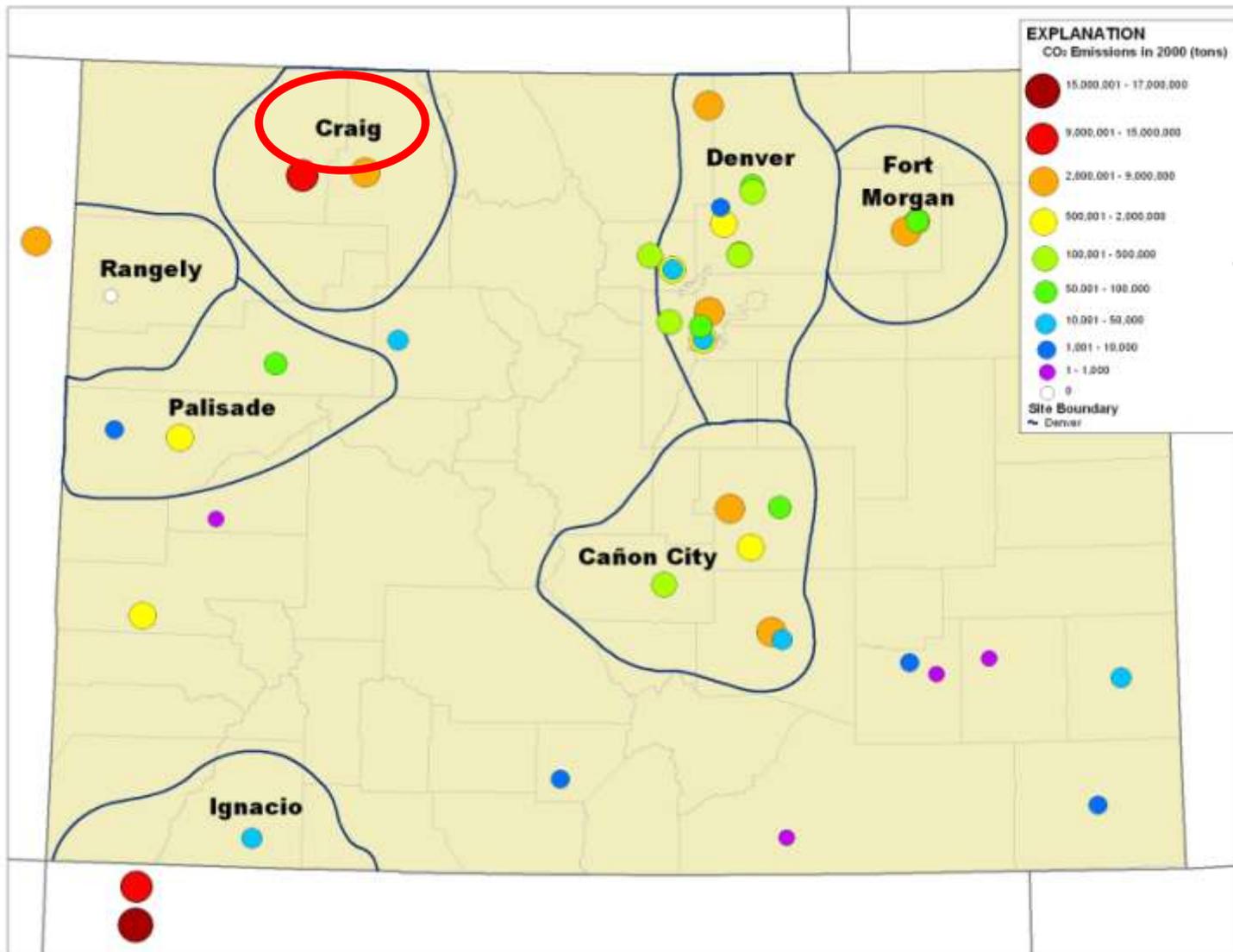


98.1 Mt total for 2007

Source: EPA

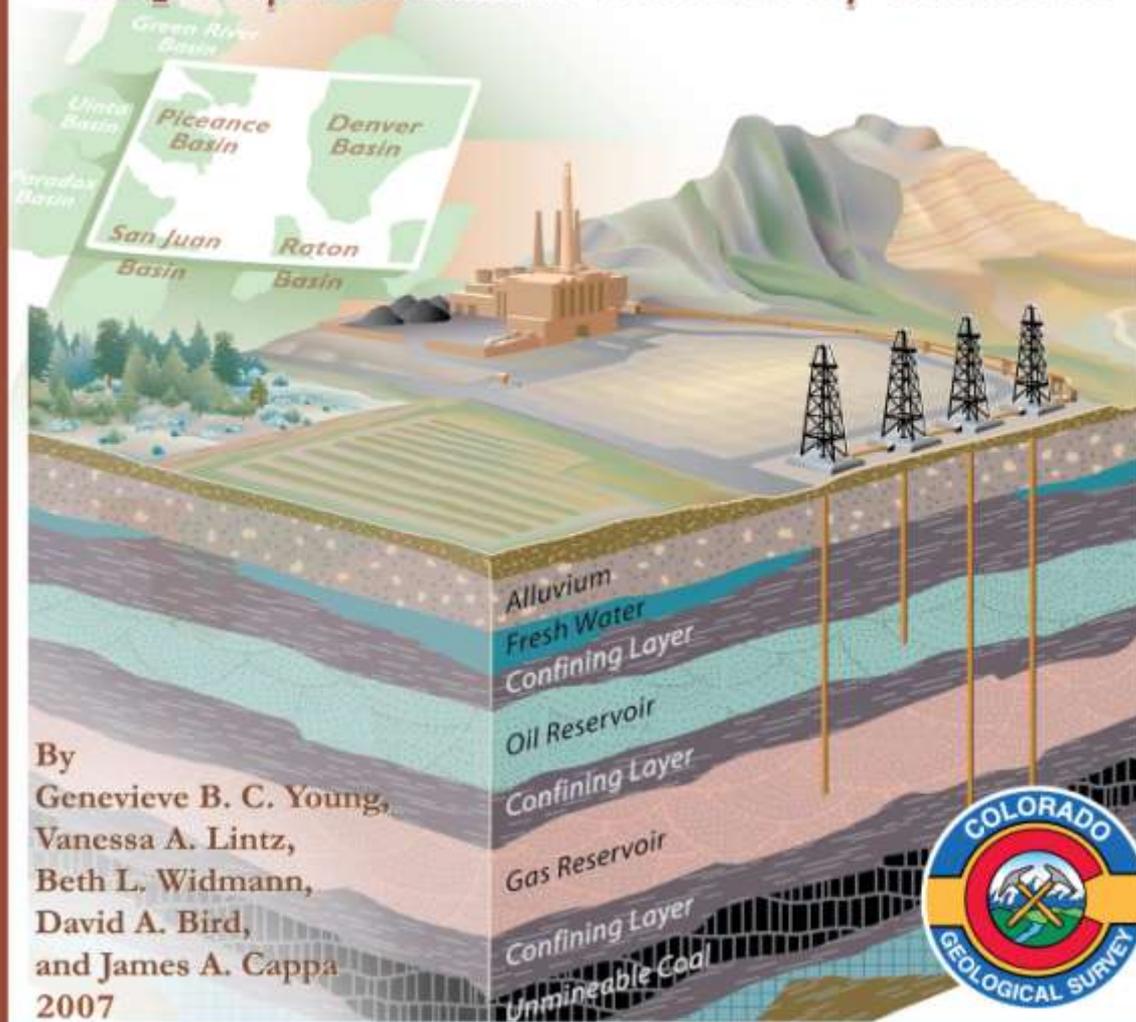
Power Plants Ranked by Emissions





RESOURCE SERIES 45

CO₂ Sequestration Potential of Colorado



By
Genevieve B. C. Young,
Vanessa A. Lintz,
Beth L. Widmann,
David A. Bird,
and James A. Cappa
2007



Preliminary Estimates of CO2 Sequestration Potential

2000 Emissions (Mt)		Geologic			Mineralization	
		Oil & Gas	Coal Beds	Saline Aquifers	Silicates	Produced Waters
Canon City	9.4	0	493	122,118	2,200	
Craig	14.4	123	11,059	46,209	30,000	0.001
Denver	14.1	557	602	129,138		<0.001
Fort Morgan	4.1	164	0	43,700		<0.001
Ignacio	31.5	186	2,809	92,142		0.009
Palisade	0.8	116	1,798	132,330	200	<0.001
Rangely	3.4	740	1,037	102,579		0.015
Total	78.5	1,886	17,798	668,286	32,400	0.026

Phase II 2005-09

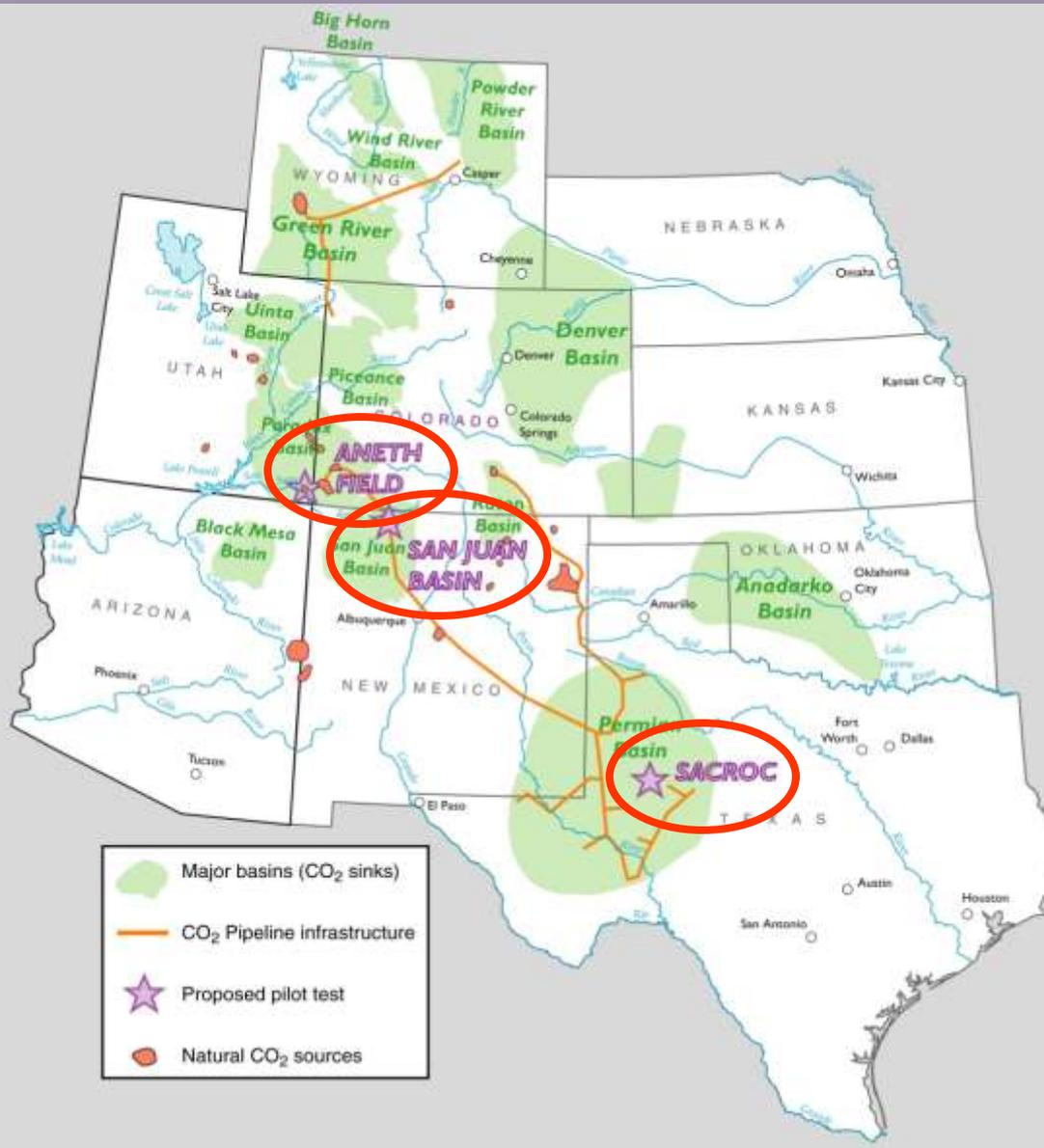
Detailed Geology

Modeling of the reservoir performance

Do the project and measure results



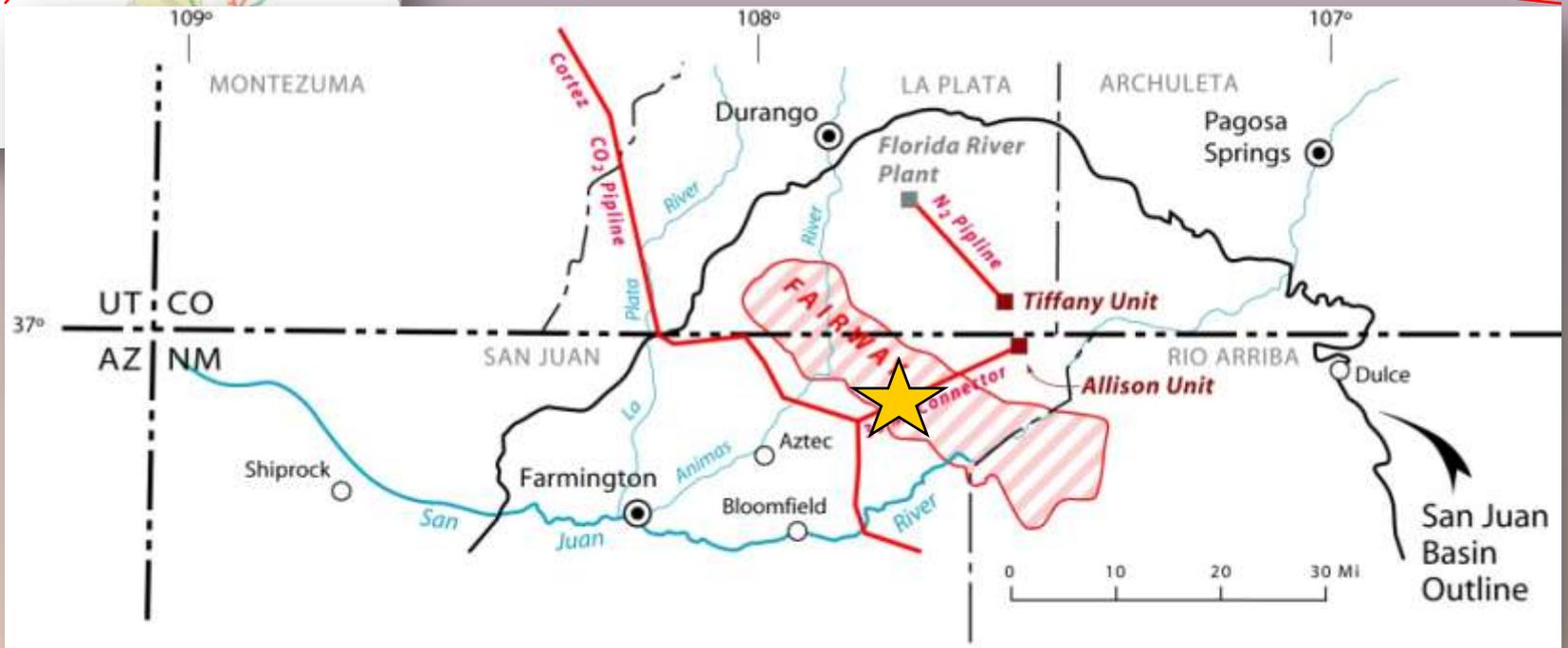
Phase II Pilots



Pilot Location



**Pump Canyon
Pilot Site**



MMV Operations

- Direct methods
 - Injection rate monitoring
 - Production well LI-COR
 - Abandoned well LI-COR
 - Gas piezometers LI-COR
 - *In situ* P/T well monitoring (fiber optic sensors)
 - *Tiltmeter arrays with InSAR*
 - *Spinner surveys*
 - H₂O chemistry & isotopes
 - Fluid/gas chemistry & isotope analysis
- Indirect methods
 - *2-D seismic surveys*
 - Crosswell seismic
 - Passive seismic
 - Borehole integrity by resistivity monitoring
 - *VSP*
 - ASTLI
 - Integrated seismic model
 - State-of-the-art reservoir models

Operations

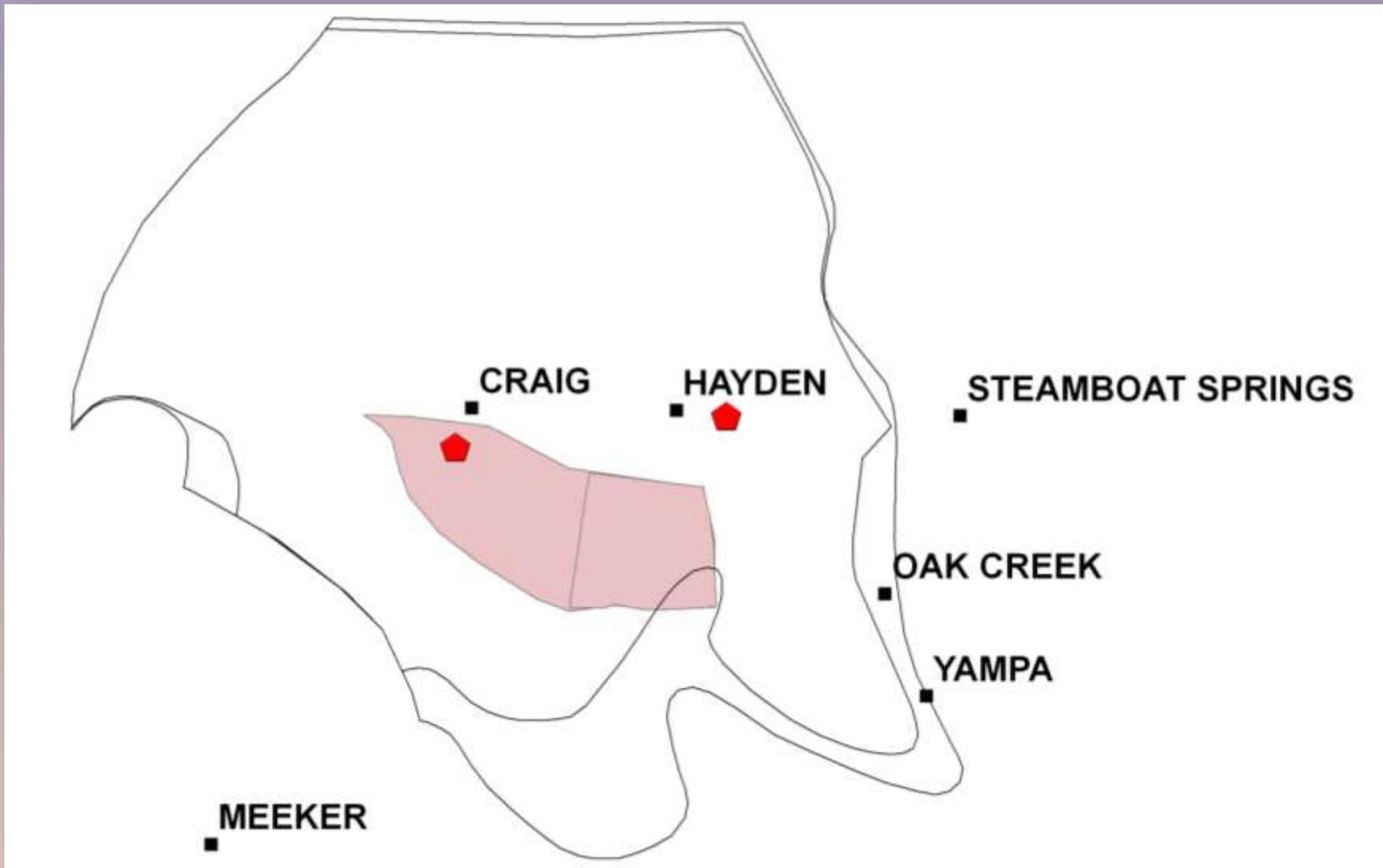
- Inject for 12 mos.; monitor intensely for 24 mos.; commence January 2008



Regulatory

- Development of a best practices manual





The Award

\$4.8 million Project

\$3.8 million from Department of Energy

\$1.0 million from Partners (20%)



Characterization of Most Promising Sequestration Formations in the Rocky Mountain Region

Organizational Chart

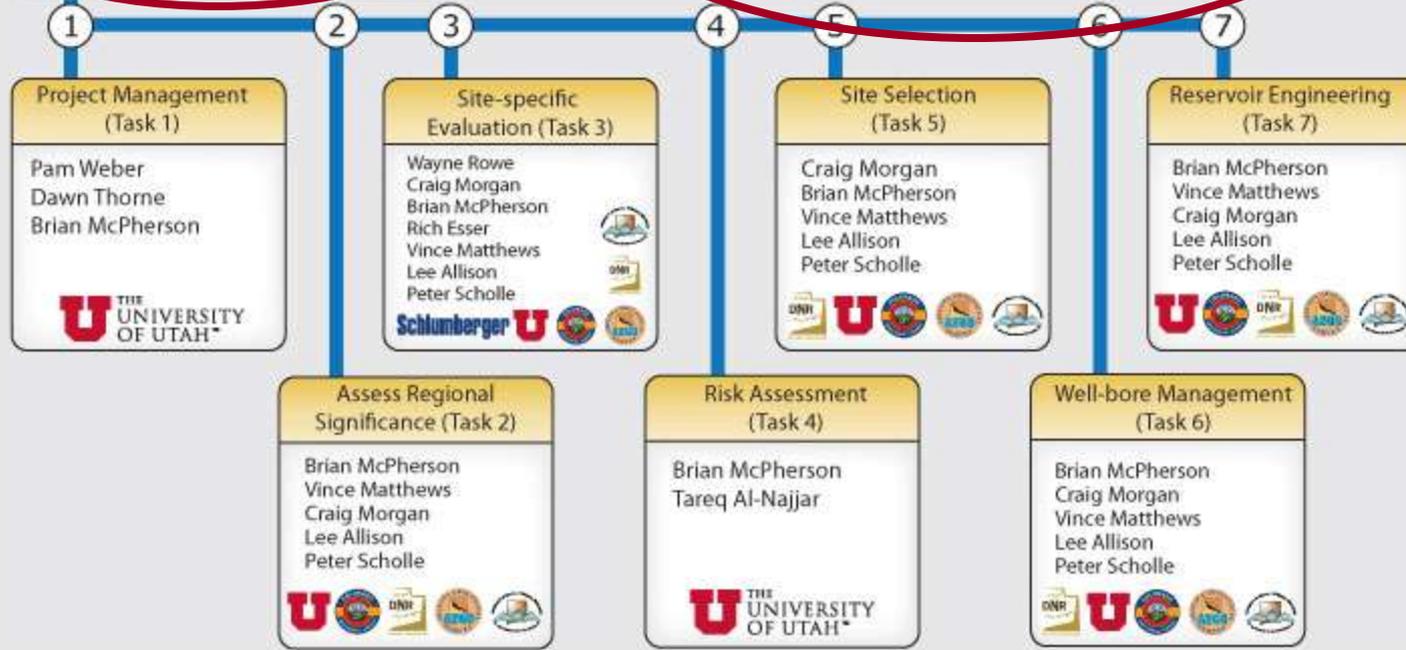
US DOE/NETL
Project Manager



PI: Brian McPherson
EGI, University of Utah
Co-PI: Vince Matthews
Colorado Geologic Surv.



Partners

The Partners

Tri-State Generation and Transmission- \$300K

Shell Exploration & Production- \$200K

Colorado Geological Survey- \$162K

Schlumberger Carbon Management- \$150K

University of Utah – Energy & Geoscience Institute - \$125K

Utah Geological Survey- \$22K

Arizona Geological Survey- \$19K

New Mexico Geological Survey- \$19K



The Plan – Year 1

Characterize the Structure

Build database

Purchase seismic

Process & interpret seismic

Map surface structure

Shoot seismic line

Pick location for drill hole

Permit well

The Plan – Year 2

Drill Well

Core Shale

Core Sandstones

Sample Waters

Analyze Samples

CO₂ Injectivity Experiments on cores

Begin Engineering Analysis & Reservoir Modeling

The Plan – Year 3

Model Reservoir

Storage Volume

CO₂ Migration

Potential Leakage Pathways

Develop Optimal Injection Program

Final Report

Extend results to Colorado Plateau

UU-EGI Regional storage Model

AZ, NM, UT, CO Geosurveys

Risk Assessment

Programmatic risk

resource and management risks that may impede project progress or costs

Sequestration (technical) Risks

risks inherent to the scientific and engineering objective of sequestering CO₂.

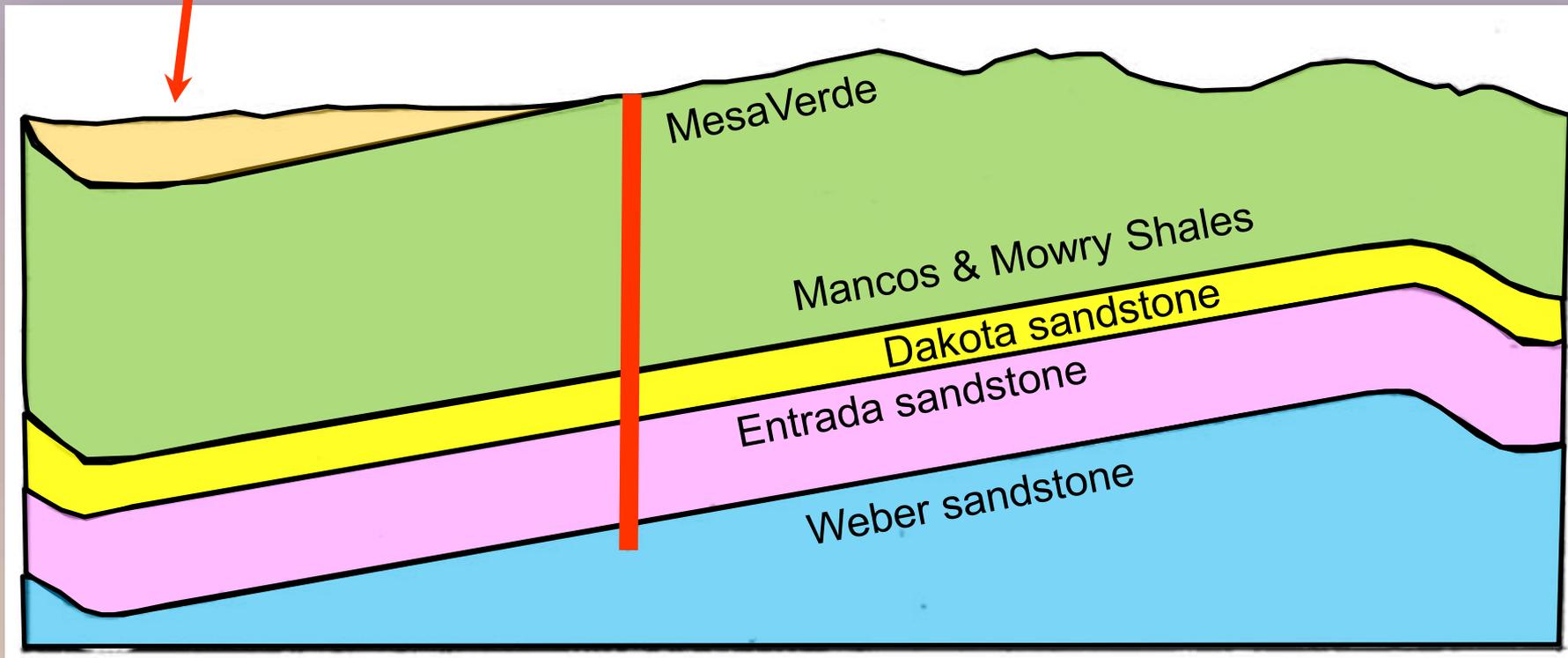


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North

South



4.8 miles





COLORADO GEOLOGICAL SURVEY

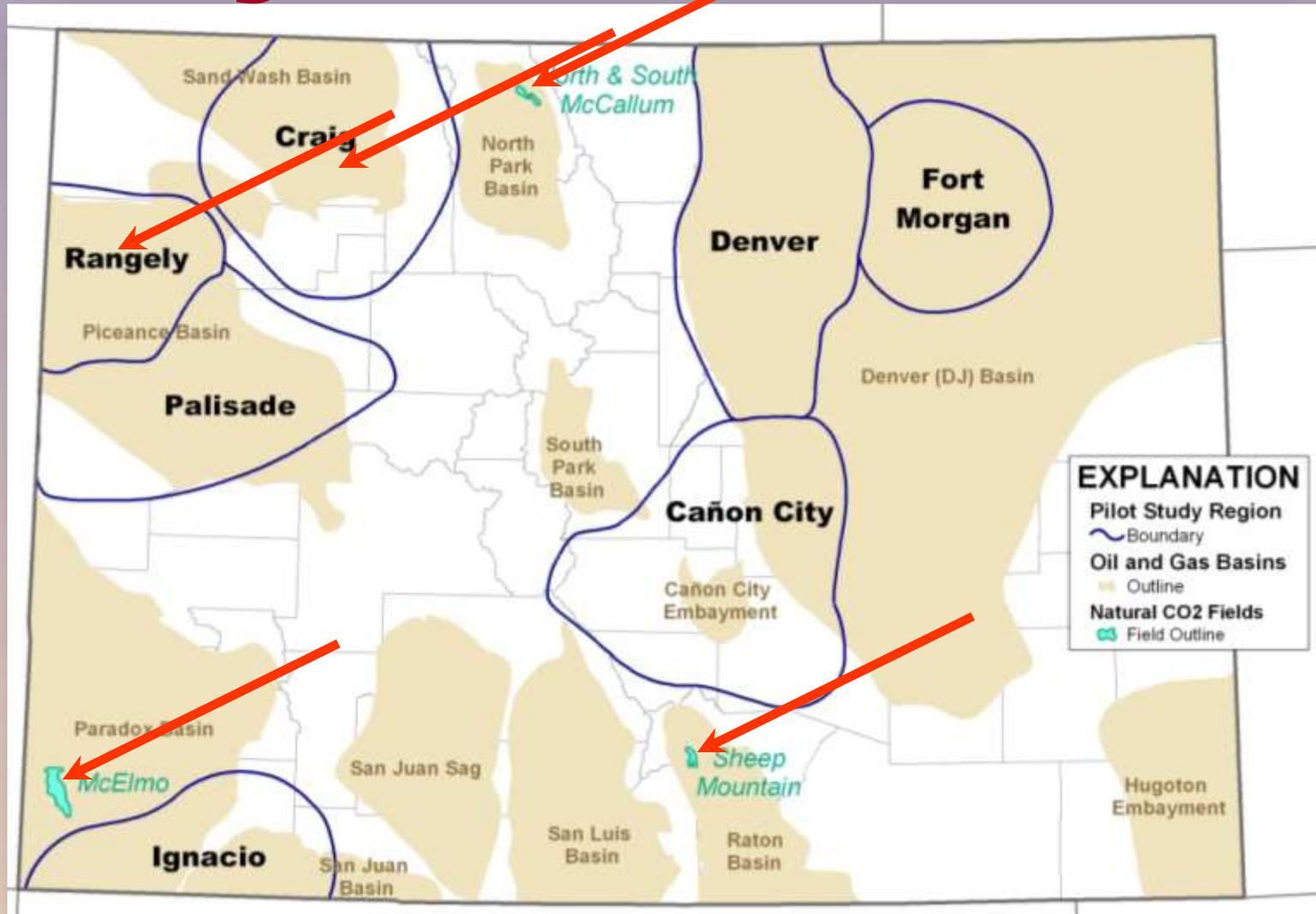




COLORADO GEOLOGICAL SURVEY



Safety



Questions?

COLORADO GEOLOGICAL SURVEY

